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JOINT GENETIC EVALUATION FOR FUNCTIONAL LONGEVITY FOR PINZGAU CATTLE

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BACKGROUND AND AIM

The Pinzgau cattle population is decreasing especially in Slovakia and Romania. Austria had 2003 7.036 Pinzgau cows (1998 8.474) with less than 25% Red Holstein (RH) genes and 4.174 with less than 6.25%. Slovakia had 2003 6.212 Pinzgau cows (<=25% RH) and 18.479 in 1998. The purebred population in Slovakia has about 3.000 cows. No comparable data including the percentage of Red Holstein genes are available for Romania. In 2003 Romania counted 42.491 Pinzgau cows (1991 112.413), but only 624 were under milk recording (Kadlecik et al., 2004).

For Pinzgau cattle no comparable breeding values are available presently. In Slovakia and Romania no genetic evaluations for functional traits are implemented.

After lactation yield, length of productive life is the second most important trait in dairy production. In cattle breeding the functional length of productive life (fLPL) is of interest. The fLPL is independent of production and other effects having a systematic influence on length of productive life.

In Austria breeding values for fLPL have been routinely estimated for bulls and cows since 1995 (Fuerst and Sölkner, 1997) using survival analysis. In November 2001 Germany and Austria implemented a joint breeding value estimation for longevity (Fürst and Egger-Danner, 2002). The objective of this paper is to check the feasibility of joint genetic evaluation for functional longevity including Slovakian Pinzgau.

MATERIAL AND METHOD

Breeding value estimation for longevity cannot be carried out with conventional methods because of the increase of generation interval as the length of productive life is only available after all daughters of a bull have died. When a cow is alive, only the lower bound of her actual LPL is available. Such a record is called "censored". The optimal use of all the available information "censored" and "uncensored" requires the use of survival techniques. These rely on the concept of a hazard function which represents the instantaneous culling risk of a cow, t days alive at t-1.

The hazard function of a particular cow is modelled as:

$$\lambda(t,z(t)) = \lambda_0(t) * \exp(z(t)'\beta)$$

where $\lambda(t,z(t))$ is the hazard function of an individual depending on time t, $\lambda_0(t)$ is the baseline hazard function assumed to follow a Weibull distribution, and $z(t)$ is a vector of (possibly time dependent) fixed and random effects with corresponding parameter vector ß. The following effects are included in the model:

Region*year*season: This time-dependent year-season effect assumes that there are systematic differences between the production regions.

*Herd*year*season*: A time-dependent year-season effect with changes on April 1 and October 1 should account for different culling policies due to the milk quota system.

Age at first calving: is the time-independent age at first calving with classes between 20 and 45 months.

*Parity*stage of lactation*: A time-dependent combined effect of lactation number and stage of lactation (1d-60d, 60d-180d, >180d) is also included as a fixed time-dependent effect.

Relative milk yield: This time-dependent effect is calculated by dividing the milk production (adjusted for parity) of a cow by the mean of the milk yields (adjusted for parity) of her herd mates for all lactations.

Relative fat- and protein content: The same procedure is applied as for relative milk yield.

Change of herd size: Major changes in the herd size due to changes in the management policy have a major impact on the risk of culling. This effect was not considered for herds with less than 8 cows. Otherwise 5 levels of change in herd size were defined (≤-50%, -49% to -16%, -15% to +15%, +16% to +49%, ≥ +50%).

Alpine grazing: In Austria alpine grazing is (in some regions) of major importance and is therefore included as a fixed time-dependent effect.

Genetic effect: A sire-maternal grandsire model is used instead of an animal model because of restrictions in computing capacity. EBVs for longevity of cows are calculated in an approximate two step procedure with the application of a sire-maternal grandsire frailty model and the estimation of the component of the animal's own additive genetic value (Ducrocq, 2001). Parameters needed for the survival analysis for longevity records to predict breeding values were estimated on data of Austrian Simmental using the formula of Yazdi et al. (2002):

$$h^2 = 4\sigma_s^2 / (\sigma_s^2 + 1)$$

The parameter estimation resulted in a heritability for fLPL of 0.12.

Presently breeding value estimation is performed with the computer program Survival Kit 3 (Ducrocq and Sölkner, 1998a and 1998b). A Weibull hazard function is assumed for the baseline hazard function, which allows the inclusion of time-dependent effects. Work has started to change to Survival Kit 5, where the concept of a piecewise hazard function is implemented (Ducrocq, 2004).

Data. Length of productive life is calculated from milk recording data and does not require the implementation of any extra recording system. Length of productive life is defined as the time from first calving to culling. Data consist of Pinzgau cattle in Austria and Germany with first calving from 1979 onwards. Cows still present in the herd or sold for dairy purposes are included as right-censored.

From the Slovakian data only data with first calving starting 1997 could be used. In the breeding value estimation 18,280 datasets remained from the Slovakian population. Cows alive or cows left milk recording are included as right-censored. The code sold for dairy purpose is not available. For the herd effect the enterprise was considered. The regional effect in Slovakia was considered for the 3 main Pinzgau regions, the other regions were combined to one region. Most of the fathers and maternal grandfathers do not have pedigree information in the dataset. Therefore their EBV includes only progeny information.

28,4% of the animals included in the joint breeding value estimation are right censored.

Table 1. Number of cows from the different countries

	Cows
Austria	91,394
Germany	1,789
Slovakia	18,280
Total	**111,463**

Publication of estimated breeding values and reliabilities. The genetic evaluation for fLPL for bulls and cows is carried out every three months. The relative risk is transformed to breeding values with a mean of 100 points and 12 points for one genetic standard deviation.

Twelve points are about half a year of longevity. The EBVs of the cows are only included in the total merit index and not published separately.

The reliability is calculated approximately. Censored records are not used, but daughters, granddaughters, paternal half-sibs and nieces are included. A reliability of about 30% is reached if 12 culled daughters without pedigree information or 3 culled daughters including pedigree information are available. A reliability of 50 is reached with 32 culled daughters without pedigree information or 19 daughters with pedigree information. For a reliability of 80% 126 daughters without and 103 daughters with pedigree information are necessary.

RESULTS AND DISCUSSION

A test run was carried out with the dataset used for routine evaluation of LPL from August 2004 from Austria and Germany and data from Slovakia. The same effects as in Austria and Germany were included.

Because of the small amount of additional data the correlation between the EBVs from the test run and the breeding value estimation from August 2004 is 0,993, which means that there is not much impact on the EBVs of Austrian bulls. The breeding value of 64 bulls changed by 3 or more points. The maximum difference was 11 points. There were only 114 new bulls with a reliability above 30 percent. The breeding values of most of the Slovakian bulls were estimated based on their daughter performance only, as no pedigree information was available. Therefore also no separate genetic trend within Slovakia could be estimated.

The data restriction age at first calving was generally increased to 45 months.

Genetic Trends. Figure 1 shows the genetic trend of functional longevity for Austrian, German and Slovak Pinzgau bulls born between 1975 and 1998. In contrast to a slight decrease in average phenotypic longevity during the last years, the genetic level is rather constant so far.

Figure 1. Genetic trend for functional longevity of Austrian, German and Slovak Pinzgau bulls.

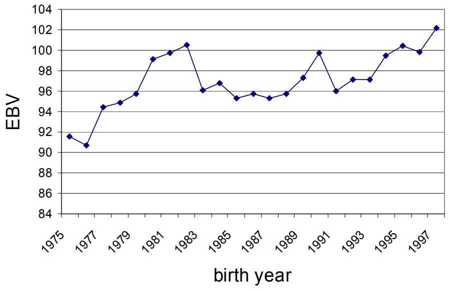
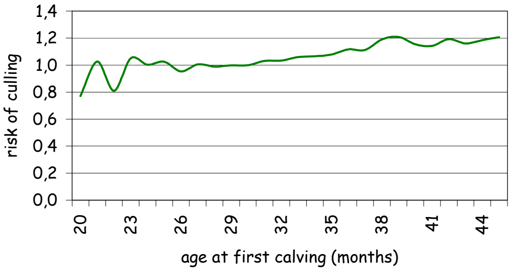


Figure 2: Effect of age at first calving.



Effects. Only cows with an age at first calving between 20 and 45 months were included. The risk of culling is slightly increasing with age at first calving (Figure 2).

From Figure 3 we may conclude that the relative milk yield as well as the relative fat and protein content have a large impact on the culling risk of a cow. The risk of a cow with a milk production one standard deviation below herd average is double compared to an average producing cow.

Figure 4 shows the different culling policies in the first and later lactations. The risk of culling is very high at the beginning of the first lactation and decreases over time. In the later lactations the risk of culling increases slightly within the lactation, but decreases with lactations.

Figure 3. Effect of relative milk yield and fat+protein content within herd.

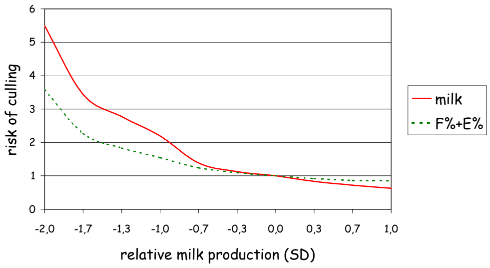
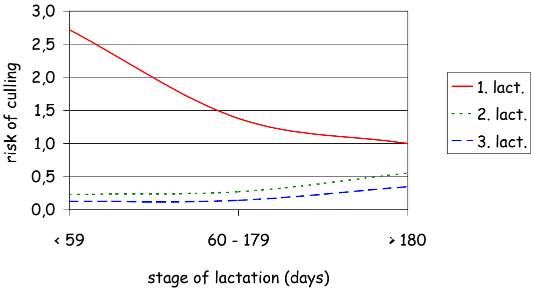


Figure 4. Effect of parity*stage of lactation.



The risk of culling is highly dependent on the change in herd size (Figure 5). If the number of cows is shrinking by 50%, the risk of culling of cows is 1.4 times higher than in a herd with stable herd size. For cows with alpine pasturing the risk of culling is reduced by 50% (Fig. 6).

Figure 5: Effect of relative herd size

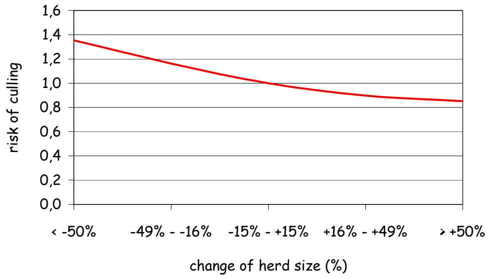
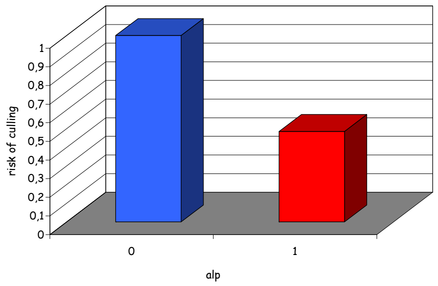


Figure 6: Effect of pasturing (alp)



JOINT BREEDING VALUE ESTIMATION FOR PINZGAU CATTLE

For the future of the Pinzgau cattle population a close cooperation between the countries is very important. Cooperation within the breeding goal and the breeding programme could achieve higher genetic response. A precondition for close cooperation in the selection procedure is, that the breeding values are comparable. As there are no Interbull breeding values for Pinzgau bulls, not even breeding values for bulls can be compared. With a joint breeding value estimation between DEA (Germany and Austria) and Slovakia (and Romania) all the bulls and cows have exactly the same breeding values. Another advantage is the higher reliability of the breeding values as all the information from the different countries are included.

The results show that a joint breeding value estimation for longevity including the Slovakian data can be implemented. As presently not very much information is included from Slovakia, the impact on the breeding values from Austria and Germany is not high. The reliability of the breeding values depends to a very high extent on the data quality. It is important that a common pedigree is further completed based on the original IDs. It would be beneficial, if information from Slovakian cows with first calving before 1997 could be included.

CONCLUSIONS

In cattle breeding the importance of fitness traits is increasing worldwide. Increased economic competition goes along with reduction of production costs. Therefore a comprehensive breeding goal including fitness is implemented in many countries. As longevity has the highest economic weight in the total merit index, a genetic evaluation of functional longevity is especially important for a rather extensively kept breed like Pinzgau. The test run shows that a joint breeding value estimation for functional longevity between Austria, Germany and Slovakia is feasible.

A joint breeding value estimation is the basis for a close cooperation within the breeding programme and an important step to increase genetic gain for the Pinzgau population.

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